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Full Length Research Paper

Farmers' understanding of pesticide safety labels and field spraying practices: a case study of cotton farmers in northern Côte d'Ivoire

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This study was carried out in cotton zones of northern Côte d'Ivoire to assess farmers' understanding of pesticide safety labels, pesticide handling and spraying practices that might potentially expose them to chemical hazards. Data was based on a stratified random sample of 165 farm households using structured interviews, multiple-visits, and direct field observations. Results showed that 50% of farmers have accurate understanding of pesticide safety labels shown to them, 17% partially understood but 33% misunderstood the labels. But their understanding of the potential negative effects of pesticides on the environment was limited. Although they interpreted the pesticide safety labels reasonably correctly and knew about the potential health risks, the precautionary measures taken against exposure were inadequate. In over half of the cases (53%), pesticide applicators did not wear any protective clothing during spraying. Efforts to reduce potential health risks from chemicals through improved farmer training will be important, but this alone does not offer a panacea because some poor pesticide practices engaged in by farmers were rooted in other reasons (cost of pesticides and procurement of protective clothing) rather than lack of knowledge alone. The study recommended integrated approaches including IPM, as a strategy for continued cotton production with minimal risks of exposure to chemicals

Key words: Cotton, Côte d'Ivoire, crop protection, human health, integrated occupational hazards, pest management.

INTRODUCTION

Pesticides assist farmers to minimize potential crop yield loss due to pests but they may also pose potential hazards to human health when inappropriately handled. Empirical studies on pesticide spraying practices and the effects of pesticides on farmers' health in developing countries have been documented in Asia (Mancini et al., 2005; Kishi et al., 1995; Antle and Pingali, 1994; Pingali et al., 1994; Rola and Pingali, 1993), in Africa (Ngowi et al., 2007; Ajayi and Waibel, 2003; Drafor, 2003; Maumbe and Swinton, 2003; Ngowi and Partanen, 2002; Rother, 2000) and Latin America (Hruska and Corriols, 2002; Crissman et al., 1998; Crissman et al., 1994). The implication of pesticide use and spraying practices on farmers' health is particularly important in cotton-based production systems because it is one of the major agricultural systems on which smallholder farmers' use substantial proportion of pesticides. Possibilities for reducing quantity of insecticides on cotton through transgenic varieties has been reported in Asia (Qaim, 2003; Pray et al., 2002; Hossain et al., 2004), but the existence of such reduction in pesticides use has not been conclusive (Pemsl et al., 2005). The prospect for reductions is lower in Sub-Saharan Africa because potential profits of transgenic cotton are comparatively less attractive for private sector seed industry in the subcontinent in the immediate future (Ajayi, 2005).

One of the efforts to improve farmers' pesticide handling practices and reduce potential hazards of the chemi-

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cals is to fix safety labels on pesticide containers to alert users of potential risks. It is expected that strict compliance with the instructions conveyed by the labels will reduce potential negative effects on human health and the environment. The objective of this study is to assess the level of farmers' understanding of pesticide labels, their field spraying practices and observance of safety procedures among smallholder farmers in cotton production zones of Côte d'Ivoire.

MATERIALS AND METHODS

Description of study area

The study area is located in northern part of Côte d'Ivoire, lying within latitude 8° and 9° North and longitude 5° and 6° West. Households in the study area generally have low level of formal education, and three-fourth (78%) of household heads did not complete formal primary education. The introduction and use of pesticides in northern Côte d'Ivoire is linked to efforts by the government to encourage farmers shortly after political independence to cultivate cotton as a cash crop (the so-called "white gold") and help to bridge gaps in economic opportunities available in the northern and southern parts of the country. An important part of the incentives to farmers to cultivate cotton was the distribution of free insecticides (100% subsidy) by government to farmers on a standard dose for every unit of land grown to cotton. As a result, the introduction of cotton crop in a given geographical zone coincides with the beginning of insecticide use in that zone. Several other economic and agricultural policy incentives embarked upon by the government to encourage cotton production have led to structural changes in the farming enterprises mix in northern Côte d'Ivoire in favour of cotton production and use of pesticides to protect the crop. From its former status as a secondary crop in the early 1960s, cotton has emerged as one of the most important crops in the modern agricultural economy of northern Côte d'Ivoire.

Sample selection

Two zones, Korhogo and Katiola regions (an administrative division) respectively were selected from the cotton producing regions of northern Côte d'Ivoire. Korhogo region is the "Long History" (LH) zone and represented locations where cotton was first introduced and insecticides have been used continuously for a long time spanning over three decades. Katiola region is the "Short History" (SH) zone and represented locations where cotton (and use of insecticides) was introduced at a more recent period of about a decade or more. In each zone, a sampling frame consisting of all cotton growing villages was obtained from the cotton development agency offices. Among these, two villages (Koni and Kokaha) were selected in Korhogo region and three villages (Logbounou, Petonkaha and Seregbokaha) in Katiola region. A random sample of 33 households per selected village was drawn, aggregating to a total sample of 165 farm households that participated in the study. An enumerator was hired and resided in each of the selected villages to collect information on farmers' household, pesticide handling and field spraying activities throughout the agricultural season. Further details on the method used to select villages and households for the study have been described elsewhere (Ajayi, 2005).

Data collection

Data on safety labels were collected in a single visit using structured questionnaires, while information on pesticide practices and sprayings were collected through multiple visits using data sheets that were designed for this purpose. The latter was supplemented by direct field observation of pesticide spraying operations and field notebooks.

Knowledge of pesticide safety labels

In each selected household, we first asked for the individual who was responsible for pesticide handling and spraying operations. For almost all households, the individual identified turned out to be the head of the household and usually a male. We then assessed the farmer's knowledge of pesticide labels by showing a sheet of paper containing pictures of thirteen different safety pictorials to the indivi-dual. They were asked what each label meant and the message that it was meant to convey to users. Enumerators were asked to record all responses in the exact words of the farmer. These were later compared with the true meaning of the labels and classified as "correct", "partially correct" or "not correct". A response was catego-rized as "not correct" when farmers gave a completely different interpretation to a label or they did not have any idea what the label meant. Responses were classified as "partially correct" if a farmer has an idea of a label (e.g. can identify the protective apparatus) but did not know how it is linked to human health or vice versa.

Pesticide practices and spraying operations

Information on pesticide and crop protection practices, storage of pesticides, post-spraying hygiene and disposal of pesticide containers was collected with the aid of a structured questionnaire. Pesticide field spraying practices of farmers were also monitored by direct observation. Resident enumerators monitored farmers' field spraying operations and collected information on protective clothing worn by applicators, precautions taken by farmers to determine the direction and speed of the wind before and during spraying (Farmers generally sprayed their crops on a prophylactic basis of two-week intervals. They were requested to notify the resident village enumerator on the eve or the morning of a day when they planned to spray their cotton field. Where several farmers sprayed their fields on the same day, the enumerator visited the fields that were located at close proximity to one another to monitor spraying operations. In the evening of the same day, the enumerator would then visit the residence of farmers whose fields could not be monitored for that day and obtained key information on the spraying activities)

RESULTS AND DISCUSSION

Knowledge about pesticide pictorials and warning labels

The assessment of farmers' knowledge on pesticide labels indicated that a half of the farmers correctly interpreted the safety labels but, some labels were less understood or misinterpreted altogether, especially those labels that warned users on potential effects of pesticides

Table 1. Accuracy of farmers' interpretation of pesticide safety labels (%).

True message of safety label	Correct	Partially correct	Wrong
Wear glasses to protect eyes	83	2	15
Put on leg boots	81	3	16
Put on hand gloves	81	2	17
Protect mouth and nose	78	7	15
Alert on possible danger of death	61	10	29
Wash after pesticides operation	52	7	41
Handling of concentrated liquids	54	13	33
Handling of dry concentrates	52	16	32
Hazardous to animals	39	18	43
Harmful to fish and flowing rivers	39	1	60
Keep securely, out of reach of children	15	2	83
Proper method for spraying pesticides	8	64	28
Wear breathing apparatus when spraying	2	78	20
Average	**50**	**17**	**33**

on the environment (Table 1).

In general, labels that advise users to protect themselves were most correctly interpreted, and four out of every five farmers understood them correctly. These were labels which advised users to protect their eyes, put on boots, hand gloves or to protect their nose and mouth. This indicated that farmers were well aware of the possible health effects of pesticides on humans. More than three-quarters of the farmers responded that themselves or someone they know in their village have suffered from pesticide-related health symptoms at one time or the other in the past. As a result, it was easier for farmers to easily understand why they should protect themselves. Observations made during spraying operations show that in 47% of the cases, farmers made efforts to protect their mouth and nose with clothes and other cotton fabric materials that they improvised on their own. However, the materials used were not always effective as they some-times absorbed pesticide solution during spraying, thus bringing the chemical closer to the applicators.

More than half of the farmers understood very well the labels that warn users of the potential health danger linked to pesticides and, the label that advised users to take a bath with water after spraying. The relatively high awareness that farmers had regarding the two labels was not surprising because farmers appreciated the biocide properties of these chemicals. The common name that farmers gave to insecticides in the study area is "*poison.*" However, the image of a tap water pump in the pictorial appeared to confuse some farmers who thought that the pictorial meant that they should "take a bath using tap water after each pesticide spraying operation" or that tap water is the most ideal liquid for preparing pesticides solutions. The label took it for granted that every farmer has access to tap water.

The safety label that was most misinterpreted by majority of farmers interviewed (83% of them) was that which warned users to keep pesticides securely out of reach of children. The precaution of wearing breathing apparatus was only partially understood by most farmers (78%), and many users did not understand the safety precaution that pesticides are harmful to fish and flowing rivers (60%). Only one of every three farmers correctly understood safety labels that warned users on the potential negative effects of pesticides on animals and the environment. Some farmers thought that the label on the potential effects of pesticides on rivers and fishes meant that they "should not go fishing after completing a pesticide field operation".

In terms of training, about one quarter (24%) of the heads of cotton-producing households in the study area had attended at least one formal agricultural training session. Most of the training sessions (78%) were organized by the cotton development agency (CIDT) while the chemical industry and NGOs provided assistance with the other trainings. About half of these training sessions focused on pesticides and spraying operations. In addition, CIDT resident village agents provided trainings to farmers on an informal and ad-hoc basis.

Table 2. Indicators used by farmers to determine wind direction before commencing and during pesticide spraying operations (%).

Wind indicator	Long history zone	Short history zone	All
Plant leaves	12	63	32
Flag/cloth	37	07	25
Sprayer vapor	85	27	62
Smoke/others	13	03	09

Table 3. Protective clothing worn by applicators during spraying (%).

Protective clothing	Long history zone	Short history zone	All
Nothing at all	30	91	53
One improvised item	46	08	32
Two improvised items	21	01	13
Three improvised items	03	--	02
Total	**100**	**100**	**100**

Storage and use of pesticides

Almost in all cases, farmers stored pesticides within their homes and rooms, and most of the farmers did not have special location for storage of chemicals. As soon as farmers acquired the quantity of pesticides needed for a given agricultural season, they kept the consignments in their homes from where they take small quantities needed during each spraying operation. The period of storage usually lasts for few months but storage may continue for more than a year in cases where the pesticides acquired were not completely used during the season. Farmers faced a dilemma in that newer, less toxic chemical formulations were more expensive than older and relatively more toxic products. Due to difference in prices, farmers procured cheaper formulated brands which were more toxic.

There were also cases of misuse of pesticides through diversion of pesticides registered for cotton to other crops or non-crop purposes e.g. for treating vegetable gardens, treatment of wounds, removal of ticks on cattle and domestic animals and the control of ants. Most cases of pesticide misuse occurred during the 'off' season by using insecticides that remained after pesticide spraying activities for the agricultural year ended.

Protective clothing and precautions against exposure

Pesticide applicators recognized the consequences of spraying against the wind or when the speed of wind is high. They took precautionary measures to observe the direction of the wind before they begin spraying, using improvised methods (In Plant leaves method, farmers observed tree leaves bent when wind blew on them to assess wind speed and direction. In "*flag/cloth*" method, piece of cloth is tied to sticks in the field and checked the direction that wind blew the cloth. "*Machine vapour*" method is used exclusively when a farmer employed a ULV electric spraying machine. The machine was first activated and the farmer observed direction to which the wind blows the fine particles of the pesticide mixture. "*Tobacco*" method is similar to machine vapor and it was used uniquely by smokers by observing the direction of cigar fumes. In dust method method, applicators took a handful of soil and dropped them off while observing the way the fine dust particles went) (Table 2).

Farmers, especially those in the "long history" zone, were careful about knowing the direction of the wind before spraying. However, in more than half of the times (53%) when pesticides were sprayed, applicators did not put on any form of protective clothing (Table 3). In the remaining cases, they made attempts to protect themselves against pesticide exposure, using improvised materials, such as face caps or local hats (29%) and a piece of cloth or handkerchief tied around the mouth and nose (24%) (The effectiveness of the different materials used was not assessed. The protective clothing consisted mainly of cotton materials and may absorb pesticide solution during spraying, and there was the possibility that they brought the chemical solutions closer to applicators). On few occasions, farmers wore boots and hand gloves. Farmers cited economic reasons (high cost of protective clothing and lack of money), hot weather, lack of access and information as major reasons for not using protective clothing.

Table 4. Methods of disposal of used pesticide containers (%).

Disposal method	Long history zone	Short history zone
Left in the field	51	59
Thrown into the bush	32	14
Washed & used within household	2	11
Washed and then sold	3	5
Packed and burnt	4	3
Buried in the soil	3	2
Others	5	6
Total	**100**	**100**

Note: some farmers used more than one type of indicators.
"Long History" zone means cotton zone is the core cotton producing locations in the core savanna where pesticides have been used for a longer period of time.
"Short History" zone means cotton growing locations where farmers began the use of pesticides relatively more recently.

Although farmers interpreted safety labels reasonably correctly, their pesticide handling and field spraying practices did not sufficiently demonstrate this level of knowledge. There were cases where farmers engaged in spraying practices that inadvertently increase the risk of exposure of applicators to pesticides because they were hoping to reduce the quantity (and hence cost) of pesticides that they use. One of such practices is to spray when wind speed is high as farmers perceived that the high wind would assist to spread the chemical solution to wider area of the field and therefore, reduce the quantity and cost of insecticides that they required.

Despite appreciable farmer awareness of the toxicity of pesticides, irregular hygienic practices and rare use of protective clothing result in greater levels of exposure for equivalent pesticide use in developing countries compared to developed countries (Cole et al., 1998). A study in Ecuador found that although more than 70% of the farmers interviewed agreed that pesticides cause serious human health problems and also 81% of them read pesticide warning labels correctly, yet the farm workers used little or no protection against exposure during spraying operations, apart from rubber boots (Crissman et al., 1994). A recent study in northern Greece (Damalas et al., 2006) show that almost all farmers (99%) are aware that pesticides can potentially impact negatively on users, but about half of farmers interviewed (46%) did not use any special protective equipment when spraying pesticides. Similar results have also been reported among pesticide applicators in India (Mancini et al., 2005).

Cotton and rice crops alone accounted for over half of the total area cultivated of all types of crops in the study area. In uplands fields, cotton and food crop fields were usually located adjacent to one another, thus exposing household members in the adjacent food crop fields to chemicals when cotton fields are sprayed.

Post-spraying and pesticide disposal practices

After spraying, applicators washed their sprayers in flowing streams and rivers close to their field and normally took a bath. Whenever they suspected cases of serious exposure to pesticides, they applied home grown remedies such as drinking lemon juice (*jus de citron*), drinking fresh milk or massaging the body with shea-butter oil (*beurre de karité*). They believed that these items would nullify negative health effects of pesticides. Farmers disposed off empty pesticide containers in various ways (Table 4). More than half of the farmers leave the containers in the field after use. Such disposal method may pose some risks to nearby stream, animal food and children health. In 13% of the cases, pesticide containers are re-used by the household or by other persons (that is, when sold). Households in the "Long History" region are fared better (containers are re-used in only 5% of the cases) compared with their counterparts in the "Short History" region where about one in every five old pesticide containers (16%) ended up being used by humans in one way or the other.

Table 4 indicates that the disposal methods still needed to be better managed; we noted however that these figures represented an improvement (in terms of posing a health hazard) over the widespread re-cycling of pesticide containers that was reported in previous studies that were carried out in the study area (CIDT, 1989; Richardi, 1992).

Conclusion and recommendation

Farmers understood some of the pesticide warning pictorials very well while others are poorly understood. The awareness that farmers had regarding the potential negative effects of pesticides on the environment was much

lower compared with their understanding of the effects of the chemicals on human health. Training and awareness programmes should be designed to target aspects of pesticide safety where farmers' knowledge was weaker Farmers interpreted some of the pesticide safety labels reasonably correctly and their awareness of the potential hazards by pesticides was high, but the protective clothing they used and precautionary measures taken against exposure were inadequate. Efforts to increase farmers' knowledge on pesticide use through improved training are important and should be encouraged, but this alone does not offer a panacea to ensure proper protection of farmers from health hazards. This is because poor pesticides practices that exposed farmers to potential health risks cannot be attributed to lack of information alone, but on other factors such as accessibility and cost of procuring protective equipments.

In addition to strengthening farmer training on safety issues, it is recommended that appropriate approaches such as Integrated Pest Management (IPM), which has the potential to reduce the quantity of pesticide use and exposure to chemicals, should be identified. Silvie et al. (2001) demonstrated that in West African cotton production zones, such approaches could both reduce insecticide usage by 40 - 50% and yet increase cotton yield. Apart from the potential reduction in exposure to chemicals, such initiatives are important to reduce incidence of outbreak of pest resistance to insecticides which were reported in the cotton zones (Martin et al., 2005) and potential negative impacts on the biological capital base of agricultural ecosystems of cotton-based systems (Ajayi, 2005) that may arise from continuous use of the chemical in cotton producing zones.

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